Advanced Kinetics: Small Arms Needs and Concepts for AAN and Beyond

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Purpose and Approach

- Suggest challenges to long-term small arms development
- Present technology-based concepts from the JSSAP "Future Small Arms Blue Sky Conclave"
- This paper intends to
  - Stimulate discussions/long-term thinking
  - Suggest potential fruitful areas for exploration
  - Set the stage to further refine and evolve concepts

Definition of Small Arms

- Definition has evolved
- Objective Family of Small Arms is providing new capabilities, and setting the stage for new concepts
- Look to 2020/2025 & beyond
- Key areas of focus for R&D now include:
  - human/weapon interface and human factors
  - energy storage and power generation
  - fire control
  - energy delivery and target coupling

Timeframes for Reference (Looking to 2025)

- The Recent Past - 27 years Back
  - 1971 (Vietnam conflict)
  - Nearly the same explosives and propellants
  - Many of the same small arms weapons
  - Little fire control on the individual weapon
- Another 27 Years Back
  - 1944 (WWII)
  - Propellants/explosives of similar energy density
  - Low penetration bullets and warheads
  - Some of the same small arms weapons as today
  - Essentially no fire control aids

Definition of Advanced Kinetics

- For the purpose of this presentation
- Delivery of energy to a target via transport of mass (inert or chemically active)
- This could include:
  - projectiles and warheads
  - unguided or guided delivery platforms
  - focussed or directed macro-streams of mass (bulk mass, particles and/or gases)
- Consider all enabling subsystems including fire control and human-weapon interface

Important Elements of Army After Next

- Deploy from much **greater standoff**
- Operate in **rapid maneuver** more frequently
- Build around increased **small unit operations**
- Employ **superior knowledge and decision speed**
- Provide **superior weapons effects** w/faster **mobility**
- Be forced to work with some **legacy systems**
- Utilize & extend capabilities of **experienced leaders**

Likely Challenges to the Combatant

- More incidents involving **sophisticated combatants**
- Enemy with significant **'national technical means'**
- Combatants & populace possibly **highly intermixed**
- **More types of targets** for small arms and individual soldiers, with **reduced target signatures**
- **Longer lethal-ranges, but lower collateral effects**
- Encounter **weapons of mass destruction**

Challenges to Advanced Kinetics Development

- **Greater lethality** from **lighter platforms**
- Support **increased mobility** and **pace of operations**
- Using streamlined logistical support - **many fewer shots per kill** will be needed
- Provide increased **lethal range,** but with **controlled collateral effects**
- Defeat **harder targets** having **reduced signatures**
- Use **situational information** in real time
- Coordinate target location and selection rapidly

Potential Additional Challenges

- Support true **joint service**, internetted operations
- **Coordinate actions**/share data with more entities
- Use faster-than-real-time thinking/predictive solutions
- Work from an integrated, all-services technology base - less room for unique or individual needs
- Apply phenomena, concepts, technologies and components from other weapons programs
- Use non-defense R&D, enabling/critical technologies

JSSAP "Blue Sky" Futures Conclave

- Ongoing effort to assess, project & stimulate small arms technologies and R&D
- Build upon then go beyond Objective Family of Small Arms (OFSA) concepts, systems, technologies
- Two-day gathering of broad subject matter experts
- Held September 1997 at Picatinny Arsenal, NJ
- Continuing to identify and develop concepts and enabling technologies for AAN and beyond
- Some results follow

Small Arms Targets and Desired Effects

- Personnel
  - armored
  - in defilade
- Wider spectrum of materiel targets including
  - light structures including many in urban areas
  - light vehicles (ground, maritime and aerial)
  - sensors (surface and aerial)
  - critical infrastructure (comms, power, fuel, mobility, etc.)
- Requirement for controlled lethality (level of lethality, lethal radius, standoff range)

Human/Weapon Interface

- Individualized weaponry ("oneness")
- Human brain/computer fusion (tailored information delivery - method and rate)
- Embedded training and status monitoring
- Weapon security/safety control linked to shooter
- Recoil management and reduction
- Potential human performance enhancement

Fire Control on the Weapon

- Stabilized image and/or weapon-mounted sight
- Indirect sighting and shared sight information
- Image enhancement and fused multi-spectrum image
- Enhanced sensory capabilities
  - inter-netted sensors and automatic use of situational data
  - alternate sensory means
  - active atmospheric compensation
  - target signature enhancement
- IFF and target kill/damage assessment aids

Guided and Smart-Guided Projectiles

- Ground-based guidance aids
  - target seeker/sensor and navigational aids
  - fire control and guidance/control computer
  - data link to projectile having trajectory control capabilities
- Projectile-based guidance aids
  - positional and attitude sensors
  - flight computer
  - seeker/sensor
  - advanced terminal fuzing capabilities
- SACLOS (initial) or ACLOS (future) configurations

Guided and Smart-Guided Projectile Concepts

- Fly to a basket or a point in space
  - relative to computed or known target location
  - absolute (3-space) position and time
- Sense projectile/target relative or absolute position
  - to permit choice of function time or location in space
  - to permit first use of directional warheads
- Provide in-flight trajectory adjustments
  - compensate for communicated trajectory deviations
  - compensate for self-sensed trajectory deviations

Energy Storage and Power Generation

- Means to provide energy in the proper form for
  - Fire control (electrical, mechanical, or chemical?)
  - Projectile or warhead launch (chemical, mechanical or EM)
  - Projectile or warhead terminal effects (kinetic, chemical and/or EM energy
- Sources
  - batteries and fuel cells, including with power management
  - truly advanced energetic propellants, explosives and incendiaries
  - recoil process; energy from environment; motion energy?

Energy Delivery and Target Coupling: General

- Projectiles (inert, reactive or explosive/energetic; ballistic or propelled)
- Warheads (ballistic or propelled)-bussed payloads
- Blast, thermal, and kinetic 'fragment' coupling at or near the target
- Projected gases/gas-particulates (contained vortices) and effective propagation and coupling to the target
- Focussed acoustics and shock waves

Advanced Kinetics Concepts: Projectile Launch

- How to achieve much faster flight to the target with acceptable recoil
  - higher muzzle velocity
  - in-flight acceleration or sustained thrust
- What are the true enabling technologies needed for practical small arms uses of:
  - electro-thermal-chemical launch
  - electromagnetic launch
  - in-bore and free-flight ramjets or electro-thermal ramjets

Advanced Kinetics Concepts: Launch and Propulsion

- Use guidance capabilities to overcome dispersion errors induced by in-flight propulsion including:
  - solid rocket motors
  - solid-fuel ramjets
  - micro gas-turbine engines
- Reduce recoil using
  - in-bore propulsion (travelling charges and rocket assist)
  - in-bore propulsion (ramjets of various types)
- Active recoil profile tailoring

Advanced Kinetics Concepts: Projectiles

- Ballistics
  - very fast spinning projectiles
  - active drag reduction
  - stability modification in flight
  - in-flight sensing and compensation for dispersion errors
  - gliding configurations
- Structural Materials
  - high density composite materials
  - energetic materials having useful structural properties
  - high force solid state actuators

Advanced Kinetics Concepts: Warheads

- Non-ideal detonation products tailored for alternate:
  - shock, blast and kinetic (fragment) energy balance
  - kinetic and thermal energy balance: thermobarics, etc.
  - still-reactive reaction products (incendiary or pyrophoric)
- Directional warheads
  - asymmetric configuration (with knowledge of attitude)
  - selectable initiation point?
  - deformable warhead?
- High energy density materials: stable & metastable

Advanced Kinetics Concepts: Warheads, Cont.

- Pure shock/blast; blast/fragment; blast/frag/thermal
- 'Volumetric' warheads: dispersed gaseous, liquid and/or solid phase fuel/oxidizer or energetic material
- Hybrid penetrator/warhead arrangements
  - hypervelocity reactive penetrator or hypervelocity macro-particle streams
  - antimateriel payload with flechettes dispersed at the target
  - very high velocity warhead with low explosive dispersal of fragment or penetrator cloud
  - miniature submunitions

Advanced Kinetics Concepts: Gases/Particulates, Waves and Shocks

- Generation and Propagation of Vortices
  - delivery of energy as a gas or gas-particle slug
  - delivery of kinetic energy with other additives
- Use of focussed acoustic energy
- Use of focussed shock waves

Other Concepts

- Alternate stability - dynamically stabilized rounds
- Novel-material projectiles - change compliance of projectile material or shape of projectile in flight
- Novel delivery platforms
  - micro aerial vehicles
  - ground-based robotics platforms
- Novel payloads
  - target signature enhancers
  - sensors for target or positional data

Some Advanced Kinetics Challenges

- Apply 'large caliber concepts' to small arms needs
- Develop affordable, guided projectile capabilities
- Utilize both defense & non-defense technology base
- Design for graceful degradation and backup capability
- Realize that the basic human nature and key physical limitations of the individual soldier will still be there
- Individualize weapons and develop them treating a person as part of the weapon system

Important Small Arms Subsystem Concepts

- Improved fire control
- Human-weapon integration
- Recoil effect attenuation
- Guided or smart projectiles
- In-flight propulsion and higher speeds
- Projectile stability concepts
- Advanced fuzing